2D and 3D ablation front hydrodynamic instability experiments on Nova*

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Our x-ray driven ablation front hydrodynamic instability experiments at Nova span 1988-present, and can be divided into three "generations". Our 1st generation experiments[1,2] consisted of planar foils with perturbations of the form $\mathbf{k}=k_x$ (1D wave vector) imposed on the drive side of the foil. A variety of drive pulse shapes, foil materials, and perturbation wavelengths and amplitudes were investigated, with growth factors of up to 80 being observed. During the foil compression stage, the perturbation growth is predominantly due to the dynamics of the rippled shock front. After shock breakout, growth is dominated by the Rayleigh-Taylor instability at the ablation front. In the linear regime (η/λ < 0.1), the perturbation growth is exponential, but with growth rate reduced from classical, similar to the Takabe description. In the weakly nonlinear regime ($\eta/\lambda \approx 0.1$), higher harmonics appear and growth in the fundamental mode is reduced, in agreement with simulations and 3rd order perturbation theory. In the very nonlinear regime (η/λ > 0.1), standard perturbation descriptions break down and the bubble growth is better described by a terminal bubble velocity picture.

Our 2nd generation experiments[3] investigated mode-mode interactions with imposed perturbations corresponding to the superposition of modes, $\mathbf{k}=\Sigma k_{x_i}$. We have done experiments with two-mode and eight-mode foils. In the linear regime, the modes grow independently with their own respective growth rates. In the nonlinear regime, in addition to the higher harmonics of the pre-existing modes, coupled terms $k_i \pm k_j$ occur, in agreement with 2nd order perturbation theory and simulations. In the 8-mode experiments, the lowest order mode is dominated by mode coupling, consistent with the beginning stages of an inverse modal cascade.

Our 3rd generation experiments[4] focus on 3D Rayleigh-Taylor growth. We have recently done experiments with an imposed 3D single-mode perturbation of the form $\mathbf{k}=(k_x,k_y)$, with $k_x=k_y$. In the linear regime, this perturbation grows exponentially with wave vector $k=(k_x^2+k_y^2)^{1/2}$. In the nonlinear regime, the perturbations evolve into broad bubbles surrounded on four corners by very dense, localized spikes with "archways" or saddle points in between, in agreement with 3rd-order perturbation theory and 3D simulations. Simulations suggest that this 3D square mode grows larger than the corresponding 2D perturbation with the same magnitude wavevector and initial amplitude. *Work performed under the auspices of the U.S. Department of Energy by the Lawrence Livermore National Laboratory under contract number W-7405-ENG-48.

[1]B.A. Remington *et al.*, Phys. Fluids B **5**, 2589 (1993) and references therein.
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[3]B.A. Remington *et al.*, Phys. Rev. Lett. **73**, 545 (1994); Phys. Plasmas, in press (January, 1995).
[4]M.M. Marinak *et al.*, Bull. Am. Phys. Soc. **39**, 1684 (1994); B.A. Remington *et al.*, Bull. Am. Phys. Soc. **39**, 1640 (1994).